**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**
**BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES**

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| Application No.: | 10/580,797 |
| Applicants: | Alain Guillard, et al. |
| Filed: | May 26, 2006 |
| Title: | GAS COMPRESSOR, UNIT FOR SEPARATING A GAS MIXTURE INCORPORATING SUCH A COMPRESSOR, AND MIXTURE OF SEPARATING A GAS MIXTURE INCORPORATING SUCH A COMPRESSOR |
| TC/A.U: | 3746 |
| Examiner: | Patrick HAMO |
| Docket No.: | Serie 6423 |
| Customer No.: | 40582 |

**APPEAL BRIEF**

MAIL STOP APPEAL BRIEF - PATENTS
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

Applicant submits this Appeal Brief to the Board of Patent Appeals and Interferences in response to the Advisory Action, dated April 29, 2010 and Final Office Action, dated March 1, 2010, finally rejecting claims 13 - 20. The final rejection of claims 13 - 20 is appealed. This Appeal Brief is believed to be timely since electronically filed by the due date of July 21, 2010, as set by the mailing of a Notice of Appeal on May 21, 2010. Please charge the fee of **$540.00** for filing this brief to Deposit Account No. 01-1375, Attorney Docket No. Serie 6423.

The Commissioner is hereby authorized to charge any appropriate fees under 37 C.F.R. §§ 1.16, 1.17 and 1.21 that may be required by this paper and to credit any overpayment to Deposit Account No. 01-1375.

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## Real Party in Interest

The present application has been assigned to L'Air Liquide, Société Anonyme à Directoire et Conseil de Surveillance pour l'Etude et l'Exploitation des Procédés Georges Claude, Paris, France. No other entity has an interest in the present application or appeal.

## Related Appeals and Interferences

Applicant asserts that no other appeals or interferences are known to the Applicant, the Applicant's legal representative, or assignee which will directly affect or be directly affected by or have a bearing on the Board's decision in the pending appeal.

## Status of Claims

Claims 9 - 12 are pending in the application. Claims 1 - 6 were originally presented in the application and were cancelled with a preliminary amendment. Claims 7 - 12 were added in the same preliminary amendment. Claims 7 - 12 were cancelled in a supplementary preliminary amendment. Claims 13 – 22 were added in the same supplemental preliminary amendment. Claim 21 was subsequently cancelled. Claims 13 – 21 (presumably intended to be 20) stand finally rejected as discussed below. The final rejection of claims 13 - 20 are appealed. The pending claims are shown in the attached Claims Appendix.

## Status of Amendments

All claim amendments have been entered by the Examiner. No amendments were proposed after the final rejection.

## Summary of Claimed Subject Matter

This invention relates to a process and to an installation for separating air by cryogenic distillation. *See Application*, page 1, lines 4 – 6.

A. Claim 13 – INDEPENDENT

Claim 13 recites a gas compressor having n stages connected in series, where n is equal to at least 3, each stage being followed by a cooler wherein at least two coolers have different pressure drops for the compressed gas, the cooler having the lower pressure drop being upstream of that having the higher pressure drop (*See Application*, page 2, lines 2 - 16).

B. Claim 14 - DEPENDENT

Claim 14 further limits claim 13. Specifically, claim 14 further requires that the cooler of the final stage of the compressor has a higher pressure drop than that of the first stage (*See Application*, page 2, lines 19 - 21)

C. Claim 15 - DEPENDENT

Claim 15 further limits claim 14. Specifically, claim 15 requires that the compressor have at least four stages, in which the cooler of the final stages of the compressor have a higher pressure drop than the first stages. (*See Application*, page 2, lines 22 - 24)

D. Claim 16 - DEPENDENT

Claim 16 further limits claim 13. Specifically, claim 16 requires at least two coolers have pressure drops differing by at least 30%, or at least 50% or even at least 100%, the cooler having the lower pressure drop being upstream of that having the higher pressure drop. (*See Application*, page 2, lines 25 - 28)

E. Claim 17 - DEPENDENT

Claim 17 further limits claim 16. Specifically, claim 17 requires at least two coolers have pressure drops different by at least 100%, the cooler having the lower pressure drop being upstream of that having the higher pressure drop. (*See Application*, page 2, lines 29 - 32)

F. Claim 18 - DEPENDENT

Claim 18 further limits claim 13. Specifically, claim 18 requires a unit for separating a gas mixture, which includes at least one compressor of claim 13 and means for sending a gas coming from and/or intended for the unit to this compressor. (*See Application*, page 3, lines 4 - 8)

G. Claim 19 - DEPENDENT

Claim 19 further limits claim 18. Specifically, claim 19 further requires a cryogenic distillation unit comprising at least one distillation column, means for sending compressed gas to a column of the unit, means for withdrawing a liquid from a column of the unit, means for vaporizing the liquid by heat exchange with a compressed gas, the compressed gas having been compressed by at least one of the final stages (or by the final stage) of the compressor and/or the compressed gas having been compressed in the compressor. (*See Application*, page 3, lines 10 - 19)

H. Claim 20 - DEPENDENT

Claim 20 further limits claim 19. Specifically, claim 20 further includes means for vaporizing the liquid by heat exchange with gas coming from one of the final stages (or from the final stage) of the compressor. (*See Application*, page 3, lines 21 - 24)

## Grounds of Rejection to be Reviewed on Appeal

1. Claim 20 stands rejected under 35 U.S.C. § 103 (a) as being unpatentable over Barchas et al. (US 5,082,481) in view Kaellis. (US 6,808,017).

## Arguments

### 1. Claims 13 to 19, and 21 are not unpatentable under 35 U.S.C. § 103(a) over Barchas et al '481 in view of Kaellis '017)

The Examiner notes that "Barchas does not explicitly disclose that the pressure drop is higher through the last set of coolers than the first. However, cooler optimization tends to involve employing the highest pressure drop one can tolerate as this permits higher heat transfer coefficients ..."

Applicants agree that Barchas et al. '481 fails to disclose that the pressure drop is higher through the last set of coolers than the first. Applicants also submit that Kaellis '017 fails to remedy this deficiency.

The Examiner notes that "Kaellis teaches that a common goal in the design of heat exchanger "is to enhance heat transfer while trying to keep the associated pressure drop low, or in other words to maximize the ratio of the heat transfer coefficient to the pressure drop. The higher the pressure drop, the more energy must be expended to pump the fluids through the heat exchanger."

Applicants agree that Kaellis '017 discloses this, but submits that this is nothing more than a restatement of what Applicants argued in the previous response, wherein we state:

> "The skilled artisan would also recognize that as a practical consideration, the designer of this system would not go to the cost and expense of such an elaborate, multi-stage compressor with a complex inter-stage cooling system, in order to elevate the working pressure of the fluid to 450 – 650 psig, then squander this expensive and hard earned pressure by needlessly dispersing 50 psig (or more) thought the somewhat pedestrian heat exchanger, which (being external to the compressor) may be as large and have as slight a pressure drop as necessary."

One skilled in the art of heat exchanger design and thus determining pressure drop within a heat exchanger will be familiar with basic pressure drop calculations such as Darcy-Weisbach, Bernoulli, etc. It is well known that fluid pressure drop calculations depend upon variables pertaining to fluid velocity or volume flowrate; properties of the fluid itself (such as specific gravity, compressibility, kinematic viscosity, etc.); and the physical properties of the

conduit (diameter, friction factor, etc.). External to the system are considerations such as elevation changes.

While the inlet pressure of the fluid will affect some of these properties such as viscosity or specific gravity, the effect is somewhat minor. All other things remaining equal, doubling of inlet pressure will not double the resulting pressure drop. It is also well understood that the velocity of the fluid is the most important determinant of both pressure drop and heat transfer (again, stated clearly by Kaellis '017). Hence, it is not necessary to increase the pressure drop through a higher pressure heat exchanger at all, in order to maintain a high level of heat transfer. Hence, one skilled in the art would not find that Barchas et al. '481 alone or in combination with Kaellis '017 would disclose the instant invention, and hence the rejection is improper and should be vacated. As claims 14 – 20 are dependent up on claim 13, the rejection is improper with regard to them as well

In the Advisory Action, dated April 29, 2010, the Examiner states that he maintains his rejection. He notes that "there are three reasons, discussed in the prior rejection, that leads the examiner to maintain this rejection."

"First, Barchas discloses three coolers after the final stage whereas there is only one cooler after the other stages. Barchas is silent as to the specifications of the coolers, but as shown in the figure, each cooler is impliedly substantially the same. Therefore, if each cooler is the same make and model, the pressure drop through the cooler system, after the final stage comprising three of the coolers of the preceding stages would be higher than the pressure drop through just one cooler.

The second reason is that Kaellis teaches that cooler design is a matter of trade off between pressure drop and cooling efficiency, and that this is well known in the art. The examiner contends that this information in combination with the implied teaching of Barchas that there are more coolers after the final stage would lead one of ordinary skill in the art to the conclusion that it was obvious that Barchas intended a higher pressure drop through the final stages, and that is why he provided three coolers whereas only one stage after each previous one, with the knowledge of cooler trade offs. It would have at least been obvious to one of ordinary skill in the art that this would be the outcome of Barchas' invention, if not the intention"

Applicant respectfully points out that the figures in Barchas are symbolic only, clearly intended only to indicate the overall process flows and generic equipment, and is not intended to be a "to scale" mechanical drawing. The examiner himself notes that Barchas

is silent to the specifications of the coolers, then presumes that they are intended to be "the same make and model".

One skilled in the art would recognize that cooler 14, which operates at approximately 50 psig, and cooler 32 which operates at approximately 350 psig, will not be of the same "make and model". Given that, other than the moisture removed in the knock-out drums, both coolers will have essentially the same *mass* flowrate, the *volume* flowrate through cooler 32 will be approximately 1/7 that of cooler 14 (given Boyle's Law). Thus, at the very least, cooler 14 will be much larger physically, and cooler 32 will have a much higher design pressure (and commensurately thicker construction).

It is indeed unclear why the draftsman for the figures in Barchas chose to indicate multiple after coolers, but there is absolutely no indication that the three coolers imply triple the pressure drop of the single coolers upstream.

Indeed, one skilled in the art of low temperature separation of cracked gas effluent, would recognize that the higher outlet pressures of compressor 38 (stated to be between 600 and 650 psig) are required in the Low Temperature Separation System (element 60). One notes that the condensing temperature of methane at 625 psig is about -120 F, and the condensing temperature of methane at 300 psig is about -160 F. Given the basic nature of the invention in Barchas (i.e. to reduce the overall refrigeration requirements of the separation of low-boiling components from cracking effluent), the higher the pressure, the better this goal is achieved. The last thing that the designer of this system would wish is to unnecessarily reduce this expensive pressure gain through heat exchangers, for which a reasonable reduction in pressure drop is moderately inexpensive to achieve.

"The last reason, which the applicant focuses most of the arguments on, is that the pressure drop would be higher through the final stage because of the higher pressure in this stage. The examiner does not contend, as applicant argues, that the higher pressure in the stage causes a higher pressure drop, but simply that the higher pressure would accommodate a higher pressure drop, so that one skilled in the art would be able to trade off some pressure drop for cooling efficiency. The examiner is prepared to accept that this is not necessarily true, and that as applicant contends one of ordinary skill in the art would like to preserve all the pressure buildup, but it would at least be obvious to one of ordinary skill that how much pressure drop is sacrificed is a design choice based on the desired cooler efficiency. Even so, at least the first two reasons for obviousness combine to make the present application unpatenable over Barchas in view of Kaellis."

With all due respect to the Examiner, Applicants have never agued that the pressure drop through the final heat exchanger would be higher simply because the exit pressure is higher. Applicants have always argued that just because ample pressure is available to accommodate a larger pressure drop after the final stage, a knowledgeable designer would not intentionally discard such hard earned pressure easily.

One skilled in the at of shell-and-tube heat exchanger design, would recognize, as discussed above, that of all the fluid dynamic variables which effect the pressure drop through a heat exchanger (either shell-side or tube-side), a change in fluid pressure has one of the weakest impacts. It is well known that for any given service, a design pressure drop of between 5 – 10 psi is not only both thermodynamically and fluid dynamically practical and achievable, but also cost effective in terms of capital expense.

Just two examples which may be found on-line (and in any design handbook) are:

> "Pressure drops are very important in exchanger design (especially for gases). As the pressure drops, so does viscosity and the fluids ability to transfer heat. Therefore, the pressure drop and velocities must be limited. The velocity is directly proportional to the heat transfer coefficient which is motivation to keep it high, while erosion and material limits are motivation to keep the velocity low. Typical liquid velocities are 1-3 m/s (3-10 ft/s). Typical gas velocities are 15-30 m/s (50-100 ft/s). *Typical pressure drops are 30-60 kPa (5-8 psi) on the tubeside and 20-30 kPa (3-5 psi) on the shellside."*
> http://www.cheresources.com/designexzz.shtml
>
> Heat Exchangers: Typical velocities in the tubes should be 3-10 ft/s (1-3 m/s) for liquids and 30-100 ft/s (9-30 m/s) for gases. *Pressure drops are about 1.5 psi (0.1 bar) for vaporization and 3-10 psi (0.2-0.68 bar) for other services*".
> http://www.us.thermal.alfalaval.com/

## Conclusion

In view of the above, it is believed that the Examiner's Final Rejection of the pending claims was not warranted and must therefore be REVERSED, together with a finding that the pending claims presented with this appeal are patentable.

Respectfully submitted,

Date: **June 29, 2010**

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## Claims Appendix

Claims 1 – 12 (cancelled)

Claim 13 (Previously Presented): A gas compressor having n stages connected in series, where n is equal to at least 3, each stage being followed by a cooler wherein at least two coolers have different pressure drops for the compressed gas, the cooler having the lower pressure drop being upstream of that having the higher pressure drop.

Claim 14 (Previously Presented): The compressor of claim 13, in which the cooler of the final stage of the compressor has a higher pressure drop than that of the first stage.

Claim 15 (Previously Presented): The compressor of claim 14, having at least four stages, in which the cooler of the final stages of the compressor have a higher pressure drop than the first stages.

Claim 16 (Previously Presented): The compressor of claim 13, in which at least two coolers have pressure drops differing by at least 30%, or at least 50% or even at least 100%, the cooler having the lower pressure drop being upstream of that having the higher pressure drop.

Claim 17 (Previously Presented): The compressor of claim 16, in which at least two coolers have pressure drops different by at least 100%, the cooler having the lower pressure drop being upstream of that having the higher pressure drop.

Claim 18 (Previously Presented): A unit for separating a gas mixture, which includes at least one compressor of claim 13 and means for sending a gas coming from and/or intended for the unit to this compressor.

Claim 19 (Previously Presented): The air separation unit of claim 18, comprising a cryogenic distillation unit comprising at least one distillation column, means for sending compressed gas to a column of the unit, means for withdrawing a liquid from a column of the unit, means for vaporizing the liquid by heat exchange with a compressed gas, the compressed gas having been compressed by at least one of the final stages (or by the final stage) of the compressor and/or the compressed gas having been compressed in the compressor.

Claim 20 (Previously Presented): The unit of claim 19, which includes means for vaporizing the liquid by heat exchange with gas coming from one of the final stages (or from the final stage) of the compressor.

Claim 21 (cancelled):

Claim 22 (Previously Presented): A method of separating a gas mixture by cryogenic distillation in a system of columns in which a gas intended for the system of columns or a gas coming from the system of columns is compressed in a compressor of claim 13, the gas leaving the final stage of the compressor being at a pressure above 10 bar, in which:

a) a stream of air is compressed to a first pressure;

b) one portion of the air at the first pressure is boosted to a second pressure of greater than 10 bar;

c) one portion of the air at the first pressure is sent for distillation in one column of the system of columns;

d) a liquid stream is withdrawn from one column of the system;

e) the liquid stream is vaporized by heat exchange with air at the second pressure, wherein

f) the stream of air at the first pressure is compressed and/or the portion of the air is boosted up to the second pressure in said at least one compressor.

## Evidence Appendix

None.

## Related Proceedings Appendix

None.